Demonstration of a Client/Server System for Remote Diagnosis of Cardiac Arrhythmias

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Health care practitioners are often faced with the task of interpreting complex heart rhythms from electrocardiograms (ECGs) produced by 12-lead ECG machines, ambulatory (Holter) monitoring systems, and intensive-care unit monitors. Usually, the practitioner caring for the patient does not have specialized training in cardiology or in ECG interpretation; and commercial programs that interpret 12-lead ECGs have been well-documented in the medical literature to perform poorly at analyzing cardiac rhythm. We believe that a system capable of providing comprehensive ECG interpretation as well as access to online consultations will be beneficial to the health care system. We present a client-server based telemedicine system capable of providing access to (1) an on-line knowledge-based system for remote diagnosis of cardiac arrhythmias and (2) an on-line cardiologist for real-time interactive consultation using readily available resources on the Internet.

Keywords: telemedicine, knowledge-based systems, model-based diagnosis, cardiac arrhythmias, Internet

INTRODUCTION

Rural health care practitioners are often faced with the task of interpreting complex heart rhythms and usually do not have specialized training in cardiology or ECG interpretation. In addition, commercially available systems for interpreting 12-lead ECG have been well-documented to perform rhythm analysis poorly. A computer-based tool is being developed in our laboratory that will provide rural health care practitioners with an automated system for interpreting complex arrhythmias.

METHODS

A prototype system was developed using resources readily available in on the Internet: NCSA Mosaic [1], a hypermedia document browser; NCSA Collage [2], an interactive distributed white-board system; and Free Software Foundation's Ghostscript [3] and Ghostview [4] PostScript language interpretation system. The prototype was created by modifying and integrating the functionality of the individual systems into a single, easy to use system. The prototype was developed in C on UNIX workstations using the X display protocol and is based on the client-server model. The system may be accessed by any authorized computer on the Internet with X display capability.

On the client side, the system assists the user in scanning an ECG, identifying the waves in the scanned ECG, and transmitting the scanned ECG and annotations to the server. On the server side, the system analyzes the annotations using an knowledge-based rhythm analysis system being developed in our laboratory. The system produces a PostScript file containing the interpretation(s) and accompanying ladder diagrams and a case-specific help file containing detailed descriptions and therapeutic indications. These files are transmitted back to the user's computer and displayed to the user by the client-side of the system. The design of the system provides for an "on-line," interactive consultation with a cardiologist.

RESULTS

Development of the prototype system required 2.5 man-months of effort to complete. The prototype system is undergoing alpha testing. For the prototype stage, all interpretations of clinical records are overread by a clinical cardiologist prior to transmission to the user.

CONCLUSIONS

This system may be beneficial in increasing the level of care of patients in the rural setting by providing the ECG interpretation expertise of an experienced cardiologist to rural practitioners on demand, which may also lead to decreasing the cost of rural health care. In addition, the system may be modified for applications in other health care domains.

REFERENCES

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